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Teachers College RECORD

A Journal Devoted to the Practical Problems of Elementary and Secondary Education and the Professional Training of Teachers

November, 1913

The Measurement of Achievement in Drawing

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TEACHERS COLLEGE RECORD

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NEW YORK CITY

The Measurement of Achievement in Drawing

By
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CONTENTS

	PAGE
Introduction	1
The Scale	9
Further Explanation of the Scale	16
The Uses of the Scale	17
The Derivation of the Scale	20
The Limitations of the Scale	29
Material for Testing Judgment of Children's Drawings	*(Insert and)* 38
The Scale Repeated	*(Insert)*

TEACHERS COLLEGE RECORD

Vol. XIV NOVEMBER, 1913 No. 5

THE MEASUREMENT OF ACHIEVEMENT IN DRAWING

By Edward L. Thorndike

We measure a child's achievement in drawing by the drawings which he produces, in connection with the conditions under which he produces them. We measure his improvement by the differences between his earlier and his later products. Every teacher is making such measurements constantly, but they are likely to be rough and not easily or surely comparable one with another. If a hundred teachers of drawing were asked to state as exactly and clearly as they could the achievement represented by the production of the drawings of Fig. 1, each in ten minutes with no copy at hand, by a twelve-year-old boy who had had the training of grades 1-5 of the New York City schools, many of them would make only such vague, rough statements as 'Good,' 'Fair,' 'Somewhat above the average,' 'Satisfactory,' and the like. If some of them did give apparently fine estimates, such as '82 by my scale of grading' or 'C+ by my scale of grading' or 'As good as the work of the thirteenth child from the top in my class of forty,' these estimates would not be easily and surely comparable one with another, or with similar estimates concerning other drawings. Each person uses a scale of his own and often a very crude one.

Consequently although we give in verbal statements and on report cards many millions of measurements of achievement in

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drawing every year, almost no use is made or can be made of them. A child may learn that his drawings are, in his teacher's estimation, better than those of other children in the same class who get lower 'marks'; but he does not know how much better they are. He may be told that his drawings of this week are better than those of last week, but not how much better they are. As to learning from all these millions of measurements how much better drawings are obtained from 100 minutes of training per week than from 50, or how much better

Fig. 1.

drawings are obtained by one city's system of instruction than by another's, or how much better drawings are obtained in the same city now than were obtained a decade ago, it is impossible.

The essential difficulty can be made clear by contrasting the case of drawings produced with that of weights lifted. We can tell just how heavy a weight a child can lift and just how much his gain has been. Any one teacher's measurement of the weight lifted is commensurate with any other teacher's, and any one teacher's measurement for one child with the same

a

c.

f.

i.

FIG. 2.

teacher's (or any other teacher's) for any other child. We could easily tell whether, age for age, children ten years from now could lift more or less (and exactly how much more or less) than children of to-day. We could easily compare the results of different systems of physical education upon lifting power. For we have for 'weight lifted' a perfectly adequate scale, starting from zero or 'just not any' weight, and so constructed that any one unit of the scale (pound, ounce, kilogram, or the like) is equal to any other unit. We know what anybody means by 'fifty pounds,' 'sixty pounds,' and the like.

m

FIG. 3.

Measurements by the scale of weight define the facts in question clearly, exactly and commensurately. For 'merit as a child's drawing' we have no adequate scale; we do not know what 'zero' merit as a child's drawing is, nor have we drawings at hand representing 1, 2, 3, 4, 5, etc., degrees of merit varying by equal steps of difference as 1, 2, 3, 4 and 5 pounds represent degrees of weight varying by equal steps.

It is the purpose of this number of the RECORD to present a provisional scale by which achievement and improvement in drawing can be measured with somewhat the same clearness, exactness, and commensurability as achievement and improvement in lifting weights, and to illustrate some of the uses of such a scale.

Consider the drawings of Fig. 2 and 3. It is obvious that *c* has more merit as the drawing of a child 8-15 than *a*, *f* than *c*, *i* than *f*, and *m* than *i*. Suppose that we know nothing more concerning this series of drawings than this patent fact of their order of merit. Even this so crude a beginning of a scale would be of service. A teacher who gave a certain sixth-grade boy's drawing (say, that of Fig. 4) a 'mark' of '70' could help us to know what achievement this '70' meant by adding "70 in the sixth grade means for me an average achievement half way between drawing *f* and drawing *i* of the Thorndike scale." She thus defines the meaning of '70' for anybody anywhere who has at hand or in memory the series of Figs. 2 and 3. The statement of the merit of the sixth-grade boy's drawing is clear.

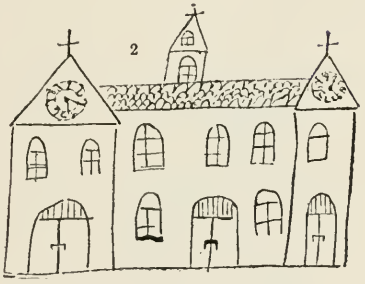


Fig. 4.

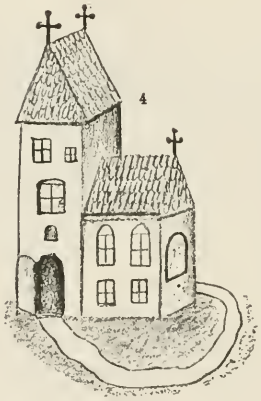
Suppose further that we had good reason to believe that the difference in merit between *a* and *f* was two times as great as the difference between *a* and *c*, that the difference between *a* and *i* was three times as great as the difference between *a* and *c*, and that the difference between *a* and *m* was four times as great as the difference between *a* and *c*. And suppose also that we had good reason to believe that the merit of 'drawing *a*' as the drawing of a child from 8 to 15 was approximately *zero*, that drawing *a* had approximately just not any merit as a drawing.*

Then our series *a* to *m* becomes a much more adequate scale, for we know now not only that a drawing 'as good as *f* of the Thorndike scale' means a certain degree of merit defined by

* Drawing *a* represents a man.

drawing *f*, but also that it means a degree of merit twice as far from zero merit as the merit of drawing *c* is, two-thirds as far from zero as *i* is, and half as far from zero as *m* is. We have not only a clear statement or description or measurement of the merit of the sixth-grade boy's drawing but also one that is easily and surely comparable with similar statements about any other drawing. If we call the difference in merit between drawing *a* and drawing *c one degree of merit*, our scale reads:

a = 0 degrees of merit
c = 1 "
f = 2 "
i = 3 "
m = 4 "



j

FIG. 5.

The sixth-grade boy's drawing (Fig. 4), being rated as half way between *f* and *i*, has 2½ degrees of merit, that is, is 2½ times as far from zero as drawing *c* is. If a certain other drawing, say that of Fig. 5, is rated as one-fifth of the way from *i* to *m* it has 3.2 degrees of merit and is 1.28 times as 'good' as the drawing of Fig. 4 in the same sense[1] that a lift of 320 pounds is 1.28 times as good as a lift as one of 250 pounds. Comparison has been made easy and sure.

[1] Not in exactly the same sense, there being certain technical differences which will be described later.

If we call the difference in merit between *a* and *c*, not 1, but 4, degrees of merit, our scale runs:

a	= 0	degrees of merit
c	= 4	"
f	= 8	"
i	= 12	"
m	= 16	"

The drawing of Fig. 4 would then be scored 10, and the drawing of Fig. 5 would be scored 12.8, but the relations would remain the same, the latter having 1.28 times as much merit, or being 1.28 times as far above zero merit. The differences between *a*, *c*, *f*, *i* and *m* may, that is, be expressed in many different numerical terms, just as five weights can be expressed as 0, 1, 2, 3 and 4 tons; 0, 2000, 4000, 6000 and 8000 pounds; or 0, 32000, 64000, 96000, and 128000 ounces.

A scale for merit of children's drawings can then be constructed by finding certain drawings which show greater and greater degrees of merit, by measuring the difference in merit between each successive two, and by measuring the distance of the one of least merit from zero merit.

TABLE 1

VALUES OF DRAWINGS *a* TO *n*

Fig.	6 or *a*	=	0	degrees of merit
"	7 " *b*	=	2.4	"
"	8 " *c*	=	3.9	"
"	9 " *d*	=	5.7	"
"	10 " *e*	=	6.5	"
"	11 " *f*	=	7.8	"
"	12 " *g*	=	8.6	"
"	13 " *h*	=	10.5	"
"	14 " *i*	=	11.8	"
"	15 " *j*	=	12.6	"
"	16 " *k*	=	13.5	"
"	17 " *l*	=	14.4	"
"	18 " *m*	=	16.0	"
"	19 " *n*	=	17.0	"

This I have done, the result being the drawings *a* to *n* shown in Figs. 6 to 19, which have the degrees of merit stated in Table 1, the difference in merit between *a* and *m* being taken as 16.

If we had a series of blocks of lead weighing 2.4, 3.9, 5.7, 6.5, 7.8, 8.6, 10.5, 11.8, 12.6, 13.5, 14.4, 16 and 17 pounds respectively, they would be a scale or graded series of standards for weight substantially as these drawings are a graded series of standards of children's drawing.

It remains to explain the scale somewhat further, to describe and illustrate some of its uses, to recount the principles of its derivation, and to make clear its limitations.

A Scale for the Merit of Drawings by Pupils 8 to 15 Years Old

FIG. 6, *a*.

This was intended to be a picture of a man.

0 merit.

FIG. 7, *b*.

This was intended to be a picture of a house.

2.4 degrees of merit.

FIG. 8, *c*.

A house.

3.9 degrees of merit.

FIG. 9, *d*.

5.7 degrees of merit.

FIG. 10, *e*.

6.5 degrees of merit.

FIG. 11, *f*.

7.8 degrees of merit.

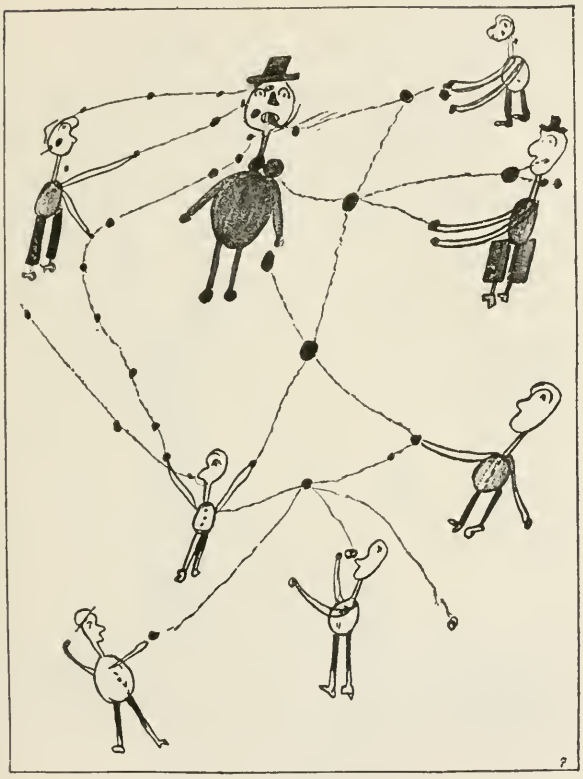


FIG. 12, *g*.

8.6 degrees of merit.

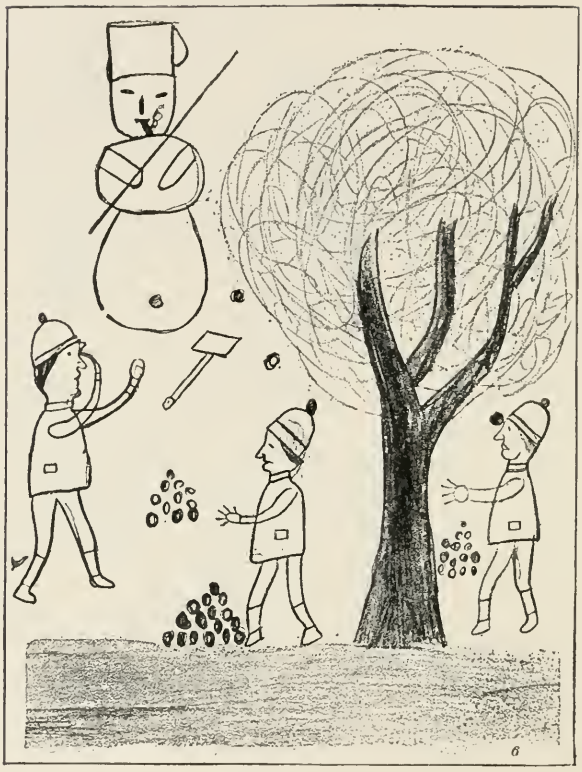


FIG. 13, *h*.

10.5 degrees of merit.

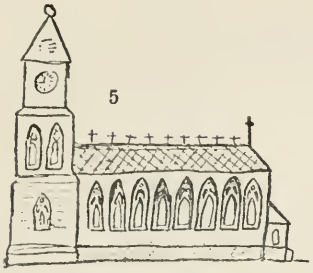


FIG. 14, *i*.

11.8 degrees of merit.

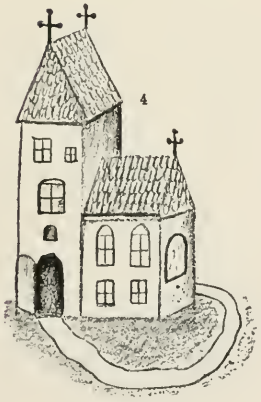


FIG. 15, *j*.

12.6 degrees of merit.

FIG. 16, *k*.

13.5 degrees of merit.

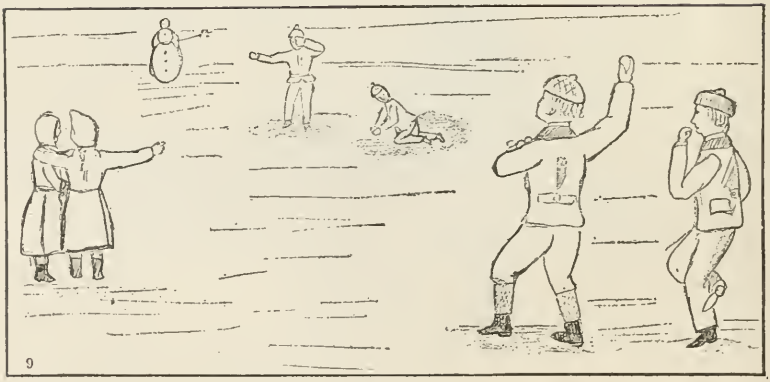


FIG. 17, *l*.

14.4 degrees of merit.

FIG. 18, *m*.

16 degrees of merit.

FIG. 19, *n*.

17 degrees of merit.

Further Explanation of the Scale

The most useful definition of zero, or 'just not any,' merit in the drawing of a child 8 to 15 is a drawing which is a *drawing*—not a scratch, a writing, a daub or a mere random product of muscular activity,—but which has just not any merit as a representation of its intended object, as a statement of its intended fact, or as a thing of beauty—which fails to portray or inform or please. We require, that is, that it be the beginning point of *merit in drawing,* not in motor power in general, and that it be the *beginning* point. Drawing *a* (Fig. 6) as a picture of a man is approximately such a zero of merit. It is a drawing, but only by chance would it be recognized as a man, and it surely has no beauty as a design. Some judges would rate it as below the beginning point of merit in drawing, and a few would rate it as above, but it surely is not far from zero as defined.

The difference of *b* (Fig. 7) from *a* (Fig. 6) is stated as 2.4 degrees of merit, or 2 4/10 times whatever is one degree of merit—the unit of difference for this graded series; the difference of *c* (Fig. 8) from *a* is stated as 3.9, or 3 9/10 times the same unit; the difference of *c* from *b* is then 1.5, or 1½ times this same unit. What then is this unit which we have called one degree of merit and may call for short, one "*merit,*" and which corresponds to one pound or one ton or one kilogram in the graded series of weights? One "merit," the unit of our scale, is *the difference of merit in children's drawings which 75 per cent of artists, teachers of art, and intelligent judges generally can distinguish, and which 25 per cent of them fail to distinguish.* That is, if a drawing *x,* of merit 1, and a drawing *y,* of merit 2, are shown to a thousand such judges, 750 of them will rate *y* as the better, while 250 of them will rate *x* as the better. Similarly for pairs of merit 2 and 3, 3 and 4, 4 and 5, 1.5 and 2.5, 2.3 and 3.3, 4.1 and 5.1, 7.6 and 8.6, etc., etc. A difference of one "merit" means a difference judged correctly by 75 per cent, and wrongly by 25 per cent, of a certain group of judges.

It is not certain that one "merit" means an equal difference whether it is the one from 0 to 1, the one from 3 to 4, the one

from 6 to 7, the one from 8 to 9, or the one from 10 to 11. It might be that, although seven hundred and fifty out of a thousand judges would judge each of these differences correctly, the differences might not be equal as the differences between 0 and 1 pound, 3 and 4 pounds, 6 and 7 pounds, and so on. The same amount of real difference in merit might be easier to distinguish low in the scale than high, or *vice versa*. With weights we can test the equality of the difference between 0 and 1 pound with that between 1 pound and 2, and so on, by replacing any one of these differences of one pound by any other of them and proving that such replacement alters nothing of consequence. With drawings we can not. We cannot take out the difference in merit between 0 merit and 1 merit and put it in place of the difference between 8 merits and 9 merits. We cannot add the merit of drawing *b* (2.4) to the merit of drawing *c* (3.9) and see whether or not we get approximately the merit of drawing *e* (6.5). When we say that the difference between the merit of drawing *f* and the merit of drawing *g* (8.6-7.8) is approximately equal to the difference in merit between drawing *i* and drawing *j* (12.6-11.8), we imply that the two differences in merit are approximately *equally often* judged correctly by competent persons—and nothing more.

The Uses of the Scale

The scale will be of service wherever the merit of the drawings of any child or group of children is to be compared with the merit of the drawings of any other child or group of children or with the drawings of the same child or group of children under other conditions.

The scale defines by samples different degrees of merit in children's drawings and represents these degrees conveniently by numbers. A teacher who wishes to tell a pupil how well he has drawn or how well he should draw can do so by a single number if the pupil sees the scale or has it in memory. A supervisor can tell teachers similarly what he expects of children in a given grade, and can define for himself or others how well any group of children can draw or should draw. The achievements of a pupil, a class or a school can be easily compared with

fixed standards or with the achievements of others by comparing the numbers which represent the achievements in question on the scale. Drawings made a thousand years apart in time or by children of different countries are made commensurate as soon as each is honestly assigned a number showing its merit by the scale. Most important of all is the service of the scale in measuring improvement. The gain of a boy or a class in drawing is measured as directly as gain in stature. If one is told that one has improved from six to seven and a half, one seeing the scale or having it in memory can know just what is meant, and so can one's teacher and everyone else concerned. Whenever we have to define the merit of a child's drawing, or compare it with another in merit, the scale is, subject to certain limitations,[2] an essential aid to be used until a better scale of the same sort is devised.

In measuring the merit of a single drawing by the scale, the drawing in question should be examined with the scale in view or well fixed in memory and a number assigned to it.[3] The number so assigned to a drawing by any single judge is, of course, far from infallible. If the same judge should so rate a thousand drawings, and then, putting these ratings aside, rate the thousand over again, he would vary, often by more than half a "merit," from his previous judgments. If ten judges should rate a drawing, each without any knowledge of the ratings assigned by the others, the ten ratings would vary. These facts are in no wise an argument against the use of the scale, but simply an illustration of the fact that people disagree more in measuring the merit of a drawing than they do in measuring the weight of a stone. Individuals disagree in all measurements whatsoever. Let a stone that weighs exactly 1,000 ounces be weighed independently by ten men using the ordinary scale found in a store and probably no two of them will assign the same number of ounces as its measure. If they assign its weight as the number of "sixteen-ounces"—*i.e.*, pounds,—to which it is nearest, more of them will assign identical numbers—62 or 63. Similarly if ten teachers measure a

[2] These limitations will be made clear in a later section.

[3] It is not wise to assign ratings on a finer scale than 0.5, 1, 1.5, 2, 2.5, etc.

drawing, say that of Fig. 20, to the nearest tenth of a "merit," probably no two of them will agree, but if they measure it to the nearest "merit," several of them will rate it alike as 2. If they should measure it as 0 or 2 or 4 or 6 or 8, etc., probably nine of them would rate it 2.

c_1

FIG. 20.

The sum and substance of all this is that any fact will be given varying measurements if the scale is made fine enough. When a teacher compares a boy's stature successively with sixty-one inches, sixty-two inches, sixty-three inches, and so on, in order to assign the proper number of inches for his stature, comparison is easy and fairly exact. Ten teachers so measuring the same boy to tenths of an inch gave ratings all between 60.2 inches and 60.6 inches. The process was simple, and the variation of their measurements was only a small fraction of the difference between the shortest and tallest human being

FIG. 21.

in the world. Ten teachers measuring the merit of the drawing of Fig. 21 (to tenths of a "merit") gave ratings of from 7.8 to 11.8. The process was not so simple; and the variation of their measurements was a large fraction of the difference between the worst and the best drawing in the world. But there

was no fundamental logical difference in the nature or value of the two sets of measurements. And *there would have been far more disagreement had they measured the drawings without the aid of our scale.* Ten other teachers measuring the merit of this drawing without the scale[4] showed a range of from 2 to 17! In general the amount of disagreement is over 50 per cent greater when the scale is not used.

We must expect a wide variation in the ratings assigned to the same drawing by this scale. One "merit" is such a difference in merit as twenty-five out of a hundred artists, teachers of art, and other competent men judge *wrongly.* Hence necessarily it must be expected that, in comparing a new drawing with the scale so as to rate it, "errors" will be frequent and large.

Just as men of science take the average of ten or twenty independent measurements of the weight of a body, if they desire to get an accurate measure of it, so we need ten or twenty independent ratings of a drawing to get an accurate measure of it. And since we are affected with eccentric notions, prejudices, and exaggerations of special details in the case of the merit of a drawing as we are not in the case of the length of a wire or the weight of a ball, it is better to have the ratings made by ten or twenty different judges, rather than by the same judge at different times. But whether there is one rating or ten, one judge or twenty, the result will be more accurate with the scale than without it.

The Derivation of the Scale

A somewhat elaborate preliminary study of forty-five drawings, mostly chosen from Kerschensteiner's *Die Entwickelung der zeichnerischen Begabung,*[5] resulted in the rough choice as a graded series from zero up, of the fourteen drawings of Figs. 6-19, and one other (c_1), shown here in Fig. 20. These fifteen

[4] They were told simply to rate as zero a drawing of just not any merit and to rate as 17 drawings as good as that of Fig. 19.

[5] I may here express my indebtedness to Dr. Kerschensteiner, whose admirable book is so useful to students of children's drawings from whatever point of view. I may also note that the reproductions of his reproductions with which I worked were not necessarily exact, and that the degrees of merit attached to them belong to the reproductions as they appear here, not necessarily as they appear in his original pages.

drawings were then submitted to artists, teachers of art,[6] and students of education and psychology, with the following instructions.

Dear Sir or Madam:

I write to ask ten or fifteen minutes of your time as an aid to me in constructing a graded set of drawings by which to measure the merit of children's drawings. Will you be so good as to arrange the fifteen reproductions enclosed in order of merit as drawings and to record the results of your arrangement below by writing 1 after the number of the drawing that is the best of the fifteen; 2 after the number of the drawing that is next best; and so on, 15 being written after the number of the drawing that has the least merit. Number 20 is a drawing of a man. So is Number 19. Number 25 is a drawing of a house. So is Number 4.

In ranking these drawings, do not make any allowance for the apparent age or training of those who drew them, but consider them all by the same standard; rate them for their intrinsic merit as drawings.

There were sent in three hundred and seventy-six ratings of the fifteen drawings in order of merit, sixty from artists of sufficient distinction to be listed in "Who's Who in America," eighty from supervisors of the teaching of art, and two hundred and thirty-six from students of education and psychology.

From these ratings it is clear that the true order of merit of these drawings is *a, b, c* (c_1 (Fig. 20) being practically equal to *c* (Fig. 8) in merit) *d, e, f, g, h, i, j, k, l, m* and *n*, since a majority of the judges regard all the drawings except *a* as better than *a*, all the drawings except *a* and *b* as better than *b*, all the drawings except *a, b* and *c* as better than *c*, and so on. We have then in these fourteen drawings a series progressing step by step from a drawing of little or no merit to a drawing such as perhaps only one child of fifty thousand under fifteen years of age could make unaided.

The differences in merit between successive drawings in this graded series were defined in each case by the percentages of judges judging correctly. For example, 94.85 per cent of the judges rated *b* as having more merit than *a*, while only 84.5

[6] Chiefly supervisors of the teaching of art in American cities.

per cent of them rated *c* as having more merit than *b*. Hence the *b-a* difference is evidently greater than the *c-b* difference in the sense of being more often or more easily distinguished. Or, again, since 73.35 per cent of the judges rated *k* as better than *j* and since 72.5 per cent of them rated *l* as better than *k*, the *k-j* and *l-k* differences are approximately equal in the sense of being approximately equally often distinguished. Such percentages of right judgments for each successive step of difference in the series were as follows:[7]

TABLE 2

94.85%	of the judges rated	*b*	as better than	*a*
84.5	"	*c*	"	*b*
88.45	"	*d*	"	*c*
69.5	"	*e*	"	*d*
82.55	"	*f*	"	*e*
69.7	"	*g*	"	*f*
89.4	"	*h*	"	*g*
81.75	"	*i*	"	*h*
70.	"	*j*	"	*i*
73.35	"	*k*	"	*j*
72.5	"	*l*	"	*k*
86.5	"	*m*	"	*l*
74.2	"	*n*	"	*m*

Now if certain hypotheses[8] about the factors which determine competent human judgments of the merit of children's drawings are allowable, it is allowable to infer the difference in merit which any given percentage of these judges (between 51 and 99) would judge rightly from the difference in merit which other percentage (between 51 and 99) does in fact judge rightly. If, for example, 750 out of 1,000 such judges rated

[7] The percentages given here are not exactly the percentages of the 376 judges, but half the percentage of the 140 artists and teachers of art plus half the percentage of the 236 students of education and psychology. That is, the judgments of an artist or teacher of art were given nearly twice as much weight as those of a student of education and psychology.

[8] I will not enter into the description or partial justification of these hypotheses, more than to state that they are essentially that the factors which make artists, supervisors of art and intelligent students generally differ in the amount of merit they attach to a child's drawing are fairly numerous, and not very disparate in amount of influence, and fairly independent one of another. The matter is rather technical, and readers who are curious about it should read chapter VIII of the author's "Mental and Social Measurements," and Dr. Hillegas's monograph on "A Scale for the Measurement of Quality in English Composition by Young People" (*Teachers College Record,* September, 1912).

n as better than *m*, it would be allowable to infer that a drawing, *x*, which was rated as better than *m* by 800 out of a thousand such judges, was 1.246 times as far above *m* as *n* was. If a drawing, *y*, was rated as better than *m* by 850 out of a thousand such judges, it would be allowable to infer that *y* was 1.536 times as far above *m* as *n* was. If a drawing, *z*, was rated as better than *n* by 650 out of the thousand, it would be allowable to infer that *z* was .571 times as far above *m* as *n* was. Similar inferences could be drawn from any other percentages of right judgments (from 51 to 99) as data. If 50 per cent of judges rate one drawing, W, as better than another, V, we can infer that there is no difference in merit between them. If one hundred per cent of judges rate one drawing U as better than another V, we can only infer that the difference is at least large, not how large it is, nor what fraction of it the difference between V and T (T being judged better than V, say by 80 per cent of judges) would be.

That something of this sort should be possible is obvious to common sense. There is some relation between the amount of difference and the percentage of judges judging it correctly. For example, drawing *n* is judged better than *m* by 76.6 per cent of certain 500 judges, better than *l* by 90.4 per cent of them, better than *k* by 95.2 per cent of them, and better than *j* by 98.2 per cent of them; and common sense rightly assumes that these increased percentages go with increased amounts of difference, and that if we had a drawing, m^1, a little better than *m*, *n* would be judged better than it by fewer than 76.6 per cent of these judges. Common sense also tells us, when aided by careful observation of human judgments, that the relation is such that a given increase (say 10) in the percentage of right judgments from fifty up means more near the hundred end than it does near the fifty end. That is, a larger increase in the difference will be required to push the percentage of votes up from 85 to 95 than from 50 to 60.

Consider the following facts concerning the ratings of drawings *i*, *j*, *k*, *l* and *m* by a group of 500 judges. *j* is ranked better than *i* by 73.7 per cent of judges, or 23.7 per cent more than would do so were they equal in merit. *k* is ranked better than *i* by 81 per cent of the judges, or 7.3 per cent more than

ranked *j* better than *i*. *l* is ranked better than *i* by 86 per cent of judges, or 5 per cent more than ranked *k* better than *i*. *m* is ranked better than *i* by 92.4 per cent of the judges, or 6.4 per cent more than ranked *l* better than *i*. Now the differences between *i* and *j*, *j* and *k*, *k* and *l*, and *l* and *m* are not in the ratio of "23.7, 7.3, 5.0 and 6.4," but the later ones are proportionally much larger. This can be seen from the fact that *when comparison was made directly* between *m* and *l*, 85.3 per cent of the judges rated *m* better than *l*. The *m-l* difference (represented by the change from 86 to 92.4) is greater than the *j-i* difference (represented by the change from 50 to 73.3).

TABLE 3

Calling the difference (D) that is judged correctly by 75% of judges, 1.00,

A difference of	0.1	D	will be judged correctly by	52.69%	of the judges
"	0.2	"	"	55.36	"
"	0.3	"	"	58.02	"
"	0.4	"	"	60.63	"
"	0.5	"	"	63.21	"
"	0.6	"	"	65.71	"
"	0.7	"	"	68.16	"
"	0.8	"	"	70.53	"
"	0.9	"	"	72.91	"
"	1.0	"	"	75.00	"
"	1.1	"	"	77.09	"
"	1.2	"	"	79.08	"
"	1.3	"	"	80.97	"
"	1.4	"	"	82.75	"
"	1.5	"	"	84.41	"
"	1.6	"	"	85.97	"
"	1.7	"	"	87.42	"
"	1.8	"	"	88.96	"
"	1.9	"	"	90.00	"
"	2.0	"	"	91.13	"
"	2.1	"	"	92.17	"
"	2.2	"	"	93.11	"
"	2.3	"	"	93.96	"
"	2.4	"	"	94.72	"
"	2.5	"	"	95.41	"
"	2.6	"	"	96.02	"
"	2.7	"	"	96.57	"
"	2.8	"	"	97.05	"
"	2.9	"	"	97.48	"
"	3.0	"	"	97.85	"
"	3.1	"	"	98.17	"
"	3.2	"	"	98.45	"
"	3.3	"	"	98.70	"
"	3.4	"	"	98.91	"
"	3.5	"	"	99.09	"

TABLE 4

A difference which	51%	of judges	judge correctly =	.037 D
"	52	"	"	.074 "
"	53	"	"	.112 "
"	54	"	"	.149 "
"	55	"	"	.186 "
"	56	"	"	.224 "
"	57	"	"	.262 "
"	58	"	"	.299 "
"	59	"	"	.337 "
"	60	"	"	.376 "
"	61	"	"	.414 "
"	62	"	"	.453 "
"	63	"	"	.492 "
"	64	"	"	.532 "
"	65	"	"	.571 "
"	66	"	"	.612 "
"	67	"	"	.653 "
"	68	"	"	.694 "
"	69	"	"	.736 "
"	70	"	"	.778 "
"	71	"	"	.821 "
"	72	"	"	865 "
"	73	"	"	.909 "
"	74	"	"	954 "
"	75	"	"	1.000 "
"	76	"	"	1.046 "
"	77	"	"	1.094 "
"	78	"	"	1.143 "
"	79	"	"	1.194 "
"	80	"	"	1.246 "
"	81	"	"	1.300 "
"	82	"	"	1.355 "
"	83	"	"	1.412 "
"	84	"	"	1.472 "
"	85	"	"	1.536 "
"	86	"	"	1.601 "
"	87	"	"	1.670 "
"	88	"	"	1.742 "
"	89	"	"	1.818 "
"	90	"	"	1.900 "
"	91	"	"	1.987 "
"	92	"	"	2.083 "
"	93	"	"	2.188 "
"	94	"	"	2.305 "
"	95	"	"	2.439 "
"	96	"	"	2.596 "
"	97	"	"	2.790 "
"	98	"	"	3.045 "
"	99	"	"	3.450 "

Just what the relation is in detail common sense does not tell us. By the hypotheses referred to earlier, it is such that if we arbitrarily call the difference which just 75 per cent of judges judge correctly (and 25 per cent wrongly) 1.00, a difference of one-tenth as much, or 0.10, will be judged correctly by

52.69 per cent, a difference of two-tenths as much, or .20, will be judged correctly by 55.36 per cent; a difference of three-tenths as much, or .30, will be judged correctly by 58.02 per cent; and so on as shown in Table 3.

A difference which 55 per cent of judges judge correctly is then .186 times as great as the difference which 75 per cent of judges judge correctly, or .186 D; a difference which 60 per cent of judges judge correctly is then .376 times as great as the difference which 75 per cent of judges judge correctly, or .376 D; and so on as shown in Table 4.

Now we know (Table 2) that 94.85 per cent of judges judged correctly the difference of *b* from *a*, and so infer from Table 4 that the *b*-*a* difference is 2.418 times the difference which would cause 75 per cent of judges to rate a drawing as better than *a*. Again we know that 84.5 per cent of judges judged correctly the difference of *c* from *b*, and so infer, again from Table 4, that the *c*-*b* difference is 1.506 times the difference which would cause 75 per cent of judges to rate a drawing as better than *b*. Treating all the facts of Table 2 in this same manner, we get Table 5, in which 1.00 equals always the amount of difference which just 75 per cent of the judges would judge correctly.

TABLE 5

b—*a*	= 2.418	D
c—*b*	= 1.506	"
d—*c*	= 1.776	"
e—*d*	= .756	"
f—*e*	= 1.389	"
g—*f*	= .765	"
h—*g*	= 1.851	"
i—*h*	= 1.343	"
j—*i*	= .778	"
k—*j*	= .925	"
l—*k*	= .886	"
m—*l*	= 1.636	"
n—*m*	= .963	"

Calling the merit of drawing *a* ZERO, we have:—The merit of *b* = 0+ (2.418 times the difference in merit from *a* which 75 per cent of the judges would judge correctly); the merit of *c* = (the merit of *b*) + (1.506 times the difference which would enable 75 per cent of the judges to judge correctly between *b* and a better drawing); the merit of *d* = (the merit of *c*) + (1.776

times the difference which would enable 75 per cent of the judges to judge correctly between *c* and a better drawing) ; and so on.

If equal differences in merit are equally often judged correctly along the scale, we may call the differences which 75 per cent of these judges judged correctly *equal,* whether they are differences from *a* or from *b* or from *c,* etc. Doing so, and calling this amount of difference 1.00, we have Table 6. These values of Table 6 are numerical values attached to the scale or series of degree of merit in children's drawings in our first description of it (see page 7).

TABLE 6

a =	0		
b =	0	+ 2.418 or	2.4
c =	2.418	+ 1.506 "	3.9
d =	3.924	+ 1.776 "	5.7
e =	5.700	+ .756 "	6.5
f =	6.456	+ 1.389 "	7.8
g =	7.845	+ .765 "	8.6
h =	8.610	+ 1.851 "	10.5
i =	10.461	+ 1.343 "	11.8
j =	11.804	+ .778 "	12.6
k =	12.582	+ .925 "	13.5
l =	13.507	+ .886 "	14.4
m =	14.393	+ 1.636 "	16.0
n =	16.029	+ .963 "	17.0

The derivation of the scale may now be described very briefly, using convenient symbols for some of the facts concerned.

Denote by A the amount of merit as a drawing by a child 8 to 15 years old possessed by specimen *a.*

Denote by B the amount of merit as a drawing by a child 8 to 15 years old possessed by specimen *b.*

Let C, D, E, F, etc., have corresponding meanings.

Denote by d_a the amount of difference in merit of a drawing, *x,* from A such that 75 per cent of the judges rate *x* as better than *a.*

Denote by d_b the amount of difference in merit of a drawing, *y,* from B such that 75 per cent of the judges rate *y* as better than *b.*

Denote d_c the amount of difference in merit of a drawing, *z,* from C such that 75 per cent of the judges rate *z* as better than *c.*

Let d_d, d_e, d_f, d_g, etc., have corresponding meanings.

B-A is measured by the fact that 94.85 per cent of the judges rate B as greater than A.

C-B is measured by the fact that 84.5 per cent of the judges rate C as greater than B.

D-C is measured by the fact that 88.45 per cent of the judges rate D as greater than C.

E-D is measured by the fact that 69.5 per cent of the judges rate E as greater than D.

F-E is measured by the fact that 82.55 per cent of the judges rate F as greater than E.

G-F is measured by the fact that 69.7 per cent of the judges rate G as greater than F.

H-G is measured by the fact that 89.4 per cent of the judges rate H as greater than G.

I-H is measured by the fact that 81.75 per cent of the judges rate I as greater than H.

J-I is measured by the fact that 70 per cent of the judges rate J as greater than I.

K-J is measured by the fact that 73.35 per cent of the judges rate K as greater than J.

L-K is measured by the fact that 72.5 per cent of the judges rate L as greater than K.

M-L is measured by the fact that 86.5 per cent of the judges rate M as greater than L.

N-M is measured by the fact that 74.2 per cent of the judges rate N as greater than M.

We infer from these facts that

$$\begin{aligned}
\text{B-A} &= 2.418\ d_a \\
\text{C-B} &= 1.506\ d_b \\
\text{D-C} &= 1.776\ d_c \\
\text{E-D} &= .756\ d_d \\
\text{F-E} &= 1.389\ d_e \\
\text{G-F} &= .765\ d_f \\
\text{H-G} &= 1.851\ d_g \\
\text{I-H} &= 1.343\ d_h \\
\text{J-I} &= .778\ d_i \\
\text{K-J} &= .925\ d_j \\
\text{L-K} &= .886\ d_k \\
\text{M-L} &= 1.636\ d_l \\
\text{N-M} &= .963\ d_m
\end{aligned}$$

Assume now that $d_a = d_b = d_e = d_c = d_f$, etc., and call this amount of difference in merit which makes a drawing be rated as better by 75 per cent of the judges, "D," or one "*merit.*"

Then B-A = 2.418 D or 2.418 "merits"
C-B = 1.506 D or 1.506 "
D-C = 1.776 D or 1.776 "
E-D = .756 D or .756 "

And if A = 0, we have:

A = 0
B = 2.4
C = 3.9
D = 5.7
E = 6.5
etc.

There is no great surety that the hypotheses upon whose full validity the exact values of our scale depend are exactly valid. Consequently, the exact numerical relations of the scale should not be used too freely in scientific quantitative studies of achievement and improvement in drawing. For the practical purposes of defining aims and measuring results in schools, however, no harm will be done by taking the scale at its face-value. A better scale will some time be devised, but the scale as it is will be of so much help and so little harm in securing clearness and making measurements commensurate that teachers should as freely rate the merit of a drawing by it as they rate the weight of a boy's lift in pounds or kilograms.

The Limitations of the Scale

An ideal scale or graded series of amounts of some one quality allows easy and accurate comparison of anything to be measured with itself and consequent easy and accurate determination of the amount in the series which is the closest match to the thing to be measured. The limitations, in this respect, of our scale for measuring the merit of children's drawings are obvious. Suppose, for example, that we wish to measure the merit of each of Figs. 22, 23, 24 and 25. It is much harder to do this than it is to measure the merit of Fig. 26 or Fig.

FIG. 22.

FIG. 23.

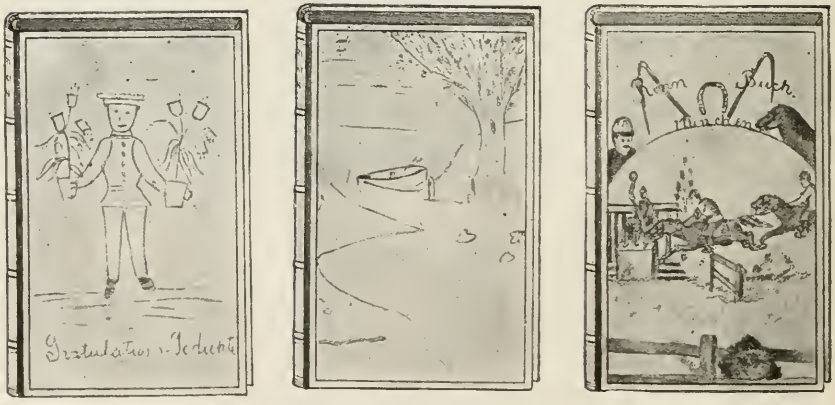


FIG. 24.

FIG. 25.

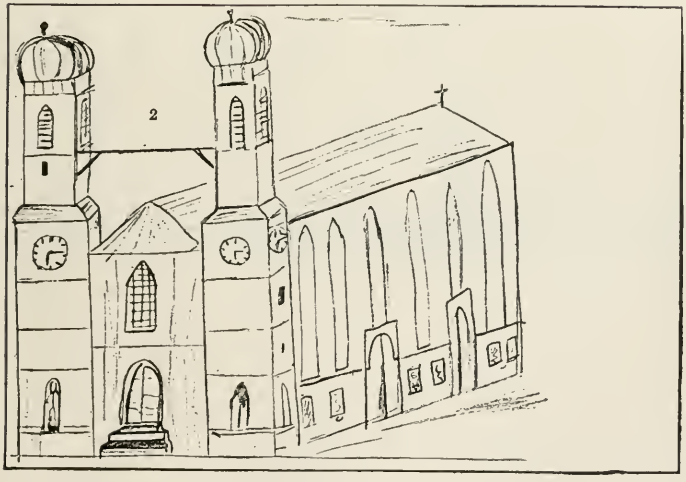


FIG. 26.

FIG. 27.

FIG. 28.

27, or Fig. 28. If we had in the scale a series of drawings of flowers of merit, 2.4, 3.9, 5.7, 6.5, 7.8, 8.6, 10.5, etc., a series of drawings of horses of merit 2.4, 3.9, 5.7, 6.5, 7.8, 8.6, 10.5, etc., a series of designs for book-covers of merit 2.4, 3.9, 5.7, 6.5, 7.8, 8.5, 10.5, etc., and a series of drawings of women of merit 2.4, 3.9, 5.7, 6.5, 7.8, 8.6, 10.5, etc., the scale would obviously be more useful to measure the merit of drawings of horses, book covers, flowers, and women than it now is.

The case can be instructively compared with the use of a graded series of iron weights, supposing that we weighed an object by lifting it and lifting the weights of the graded series until the one of them was found that was the closest match. If one had to so weigh a lump of lead, a block of wood, an empty band box, a ten foot bamboo pole, and a live kitten, he would find comparison difficult and insecure.

An ideal scale also would present a graded series in the form of *integral* multiples of some convenient unit and *uniform fractions* of that unit. Thus, supposing as before that we weighed an object by lifting a graded series of iron weights in comparison with the object, it would be more convenient if the series ran 1 lb., 1¼ lb., 1½ lb., 1¾ lb., 2 lb., 2¼ lb., 2½ lb., and so on than if it ran .17 lb., .57 lb., .92 lb., 1.08 lb., 1.64 lb., 2.3 lb. Here again the limitations of our scale are obvious. The unit—the amount of difference in merit which 75 per cent of our 376 judges judged correctly—is suitable enough, but the series does not present very convenient multiples of it.

These limitations can be remedied in part, though we may not expect to measure the merit of a child's drawing as easily and accurately as the weight of his body. The scale can be extended in scope to include specimens of maps, mechanical drawings, decorative drawings and designs of various sorts, drawings of specified objects, and the like; and with proper methods of investigation and enough labor, specimens can be found of these several sorts of drawing of exactly 1 'merit,' 1½ 'merits,' 2 'merits,' 2½ 'merits,' and so on up to 17 'merits' which is as far as a scale for children's drawings needs to extend. The labor involved is, however, very, very great. In order to get one specimen proved to be between .99

and 1.01, it would probably be necessary to collect with great care at least fifty drawings by very stupid children, to have them measured by at least 100 judges in comparison with the scale as it now is, then to select 20 of them to be so measured by 200 more judges, and then to select ten of these to be so measured by 300 more judges, and finally to have the two or three or four of these that were between .99 and 1.01, by the opinion of the 600 judgments so far, measured by 400 more judges. If the present scale were not at hand as a basis, the labor would be much greater. The improvement of the scale in these respects must then be a gradual achievement of several years. At this time, I will only indicate some of the first-steps to be taken and provide some of the material to be used.

We may classify children's drawings roughly by the interests which they serve and to which their production is due, as informational, representative and decorative. The motive for informational drawings, such as those of Fig. 29 and 30, is to state facts. The lines of the drawing are used as a language to tell a story, and words are often used freely along with them. This factual, informational drawing develops naturally into the drawing of maps, house-plans, cross-sections and the like (as in Fig. 31) and, with the provision of proper training, into mechanical drawing and the schematic drawing of the sciences.

Representative drawings, such as those of Figs. 32 and 33, seek to mimic for the eye the sensations it would have from the object in question, to present, not certain facts about an object, but a view or picture of it. Teachers of art usually think of drawing primarily as such an art of representing the eye's single glimpse of an object. They would usually object to a child's showing the front and both ends of a house in one drawing regardless of his assertion that it does really have two ends.

The connection of representative drawing with the more primitive informational drawing may be thought of in either of two ways. We may say that informational drawing becomes representative when the aim is to inform us *rather exactly of how the object looks from a single point of view.* Or we may say that informational drawing is representative drawing which

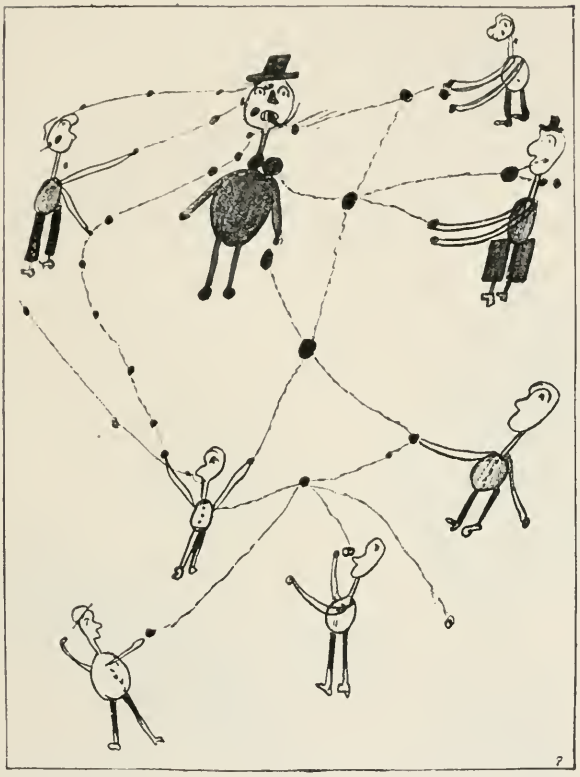


Fig. 29.

Fig. 30.

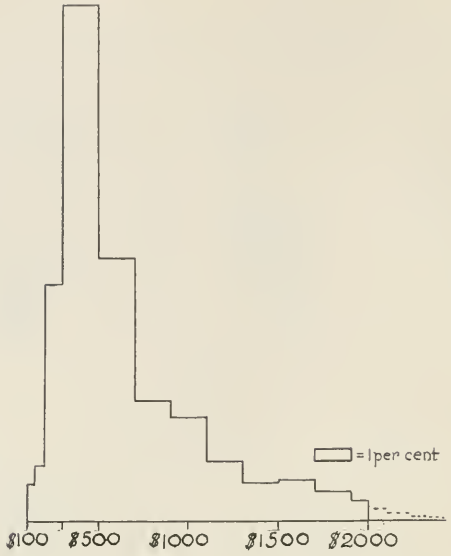


FIG. 31.

aims only to represent to the eye certain abstract features and elements, or general contours and characteristics, of the object. The former statement seems to me the more useful one.

When the aim is to create something beautiful we have what I have called decorative drawing. Examples of such are somewhat hard to find in the printed collections of children's drawings, since it is with flowers, ribbons, and the like rather than with pencil and paper that children usually try to produce effects to which they ascribe beauty. But the specimens of

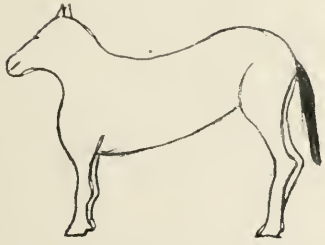


FIG. 32.

FIG. 33.

Figs. 34 and 35 (from Kerschensteiner's collection) will serve the purpose. Drawings of any one of these three varieties may also please us by humor, originality, 'finish,' the interest of the subject itself, the organization of the details to make an interesting total, and other qualities which satisfy the mind, or suggest competence.

Now the specimens (*a, b, c, d,* etc.) of our scale represent a mixture of informational and representative drawings in the lower grade of the scale, and representative drawings in the upper grades of the scale. With the possible exception of *n*, probably no one of them was intended by its producer to be a thing of beauty. The scale, as it stands, is not at all suitable

as a means of measuring the merit of children's drawings as decorations, things of beauty, "artistic" productions, and does not pretend to be. It is also not at all suitable as a means to measure the merit of informational drawings above very low grades. It therefore needs especially specimens of decorative drawing of all grades, and of informational or scientific or factual drawing of medium and high grades.

The judges whose ratings determine what the merit is which the scale as it stands does measure probably interpreted merit in the main as "merit as a representative drawing," "merit as a picture of an object as it looks," giving some weight, however, to informational efficiency, beauty, humor, the organization of the details into a picture, and the like, throughout. The term was deliberately left vague since for the present a scale for what a composite group of competent judges regard as general merit in a child's drawing seems more desirable than a special scale for merit in some one rigidly defined sense. Later it will be a simple matter to have these same drawings rated for beauty, originality, the organization of details, and other special features or sorts of merit.

Material for Testing Judgment of Children's Drawings and for the Improvement and Extension of the Scale

I add some fifty drawings which, together with those appearing in the text but not used in the scale itself, will be of service in testing the competence of teachers to measure the quality of drawings. They will also, when each one has been graded by a sufficient number of artists, teachers of art, and other suitable judges, enrich the scale as it stands. These are printed in such form that they may be easily cut up for use in such experiments. There is also added a sheet presenting the scale itself in convenient form to be hung in the class room or used by the teacher or scientific worker in grading drawings.

A Scale for the Merit of Drawings by Pupils 8 to 15 Years Old

The numbers give the amount of merit of the drawings as judged by about 400 artists, teachers of drawing, and men expert in education in general

0

2.4

10.5

3.9

11.8

Univ. of California

5.7

12.6

6.5

13.5

7.8

14.4

8.6

16.0

17.0

Specimens of Children's Drawings to be used for Experiments in Grading and for the Improvement of the Scale

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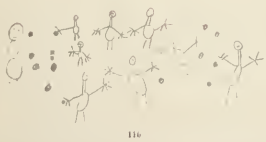

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